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(54) **SURGICAL INSTRUMENT**

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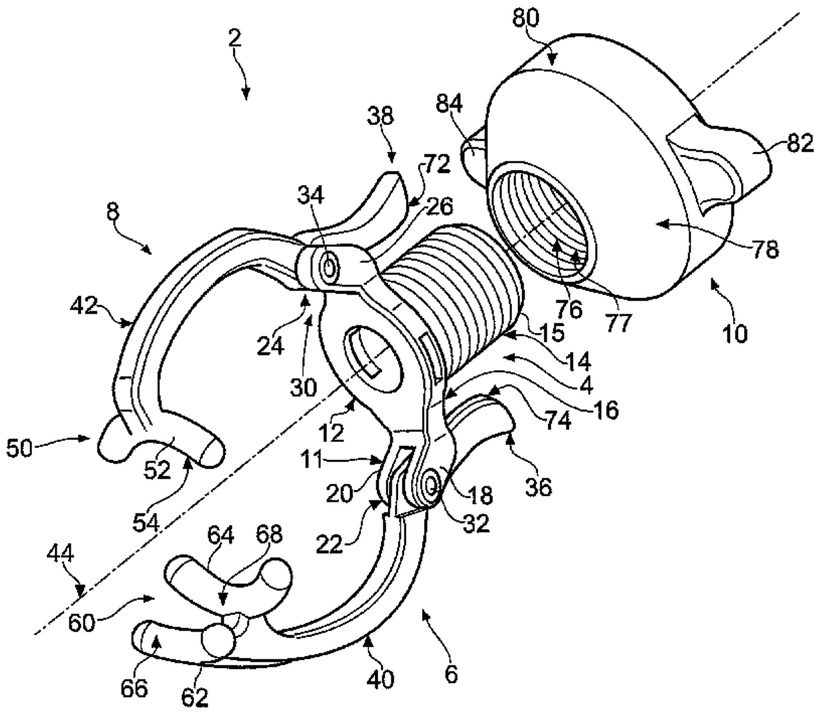
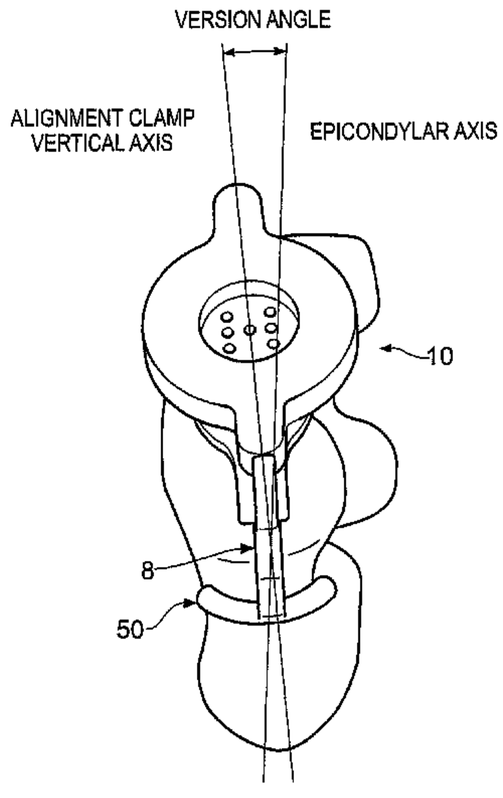
(57) **ABSTRACT**

An instrument (**2**) for aligning a surgical tool, the instrument (**2**) comprising, a body portion (**4**) having a tool guide (**90**), first and second arms (**6**), (**8**) operatively connected to the body portion (**4**) and adapted to engage a bone, and urging means (**10**), acting between the body portion (**4**) and the first and second arms (**6**), (**8**), for urging the first and second arms (**6**), (**8**) into engagement with a predetermined portion of a bone, thereby clamping the arms (**6**), (**8**) onto the bone and aligning the tool guide (**90**) with the bone.

8 Claims, 4 Drawing Sheets





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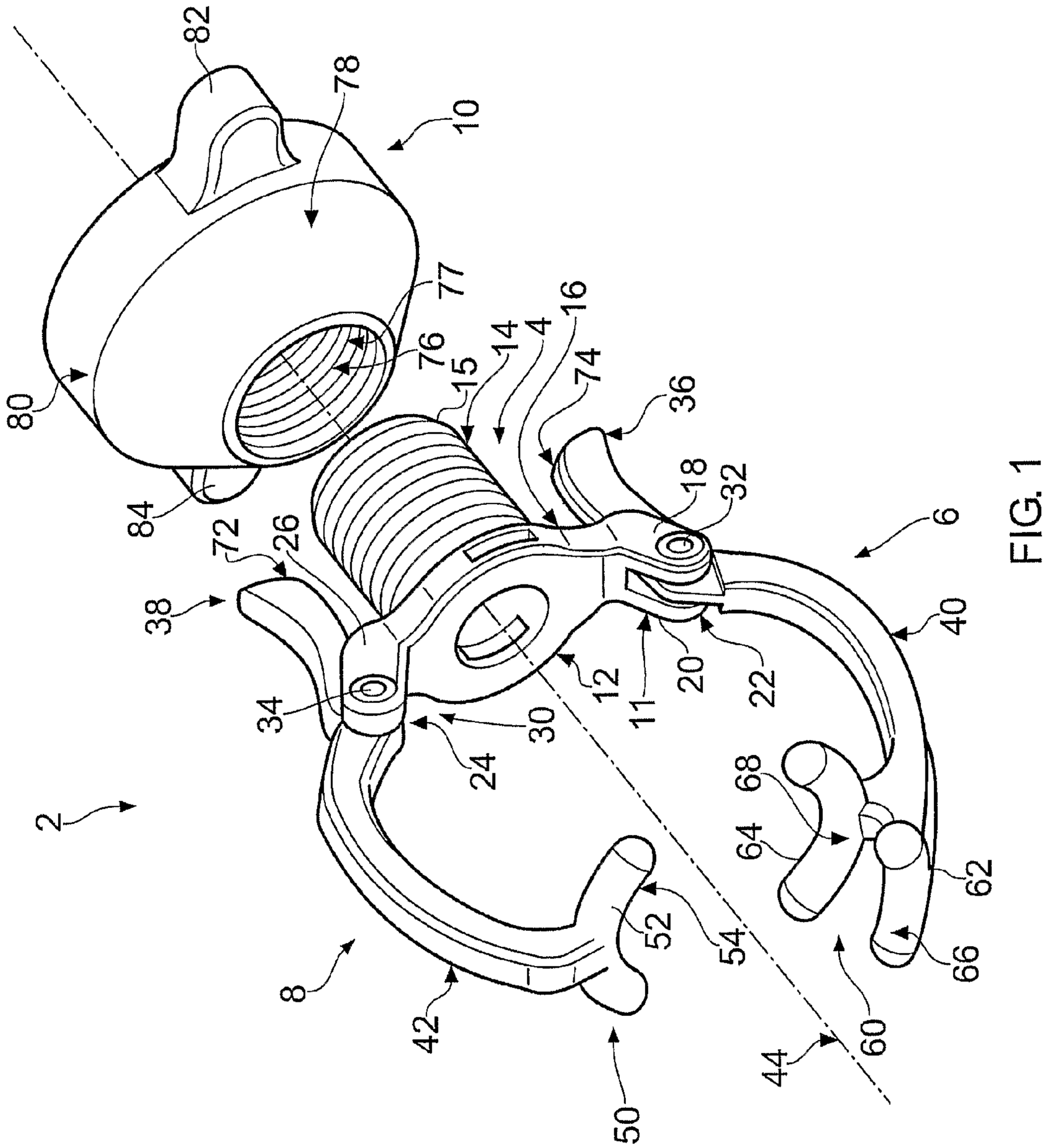
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FIG. 1

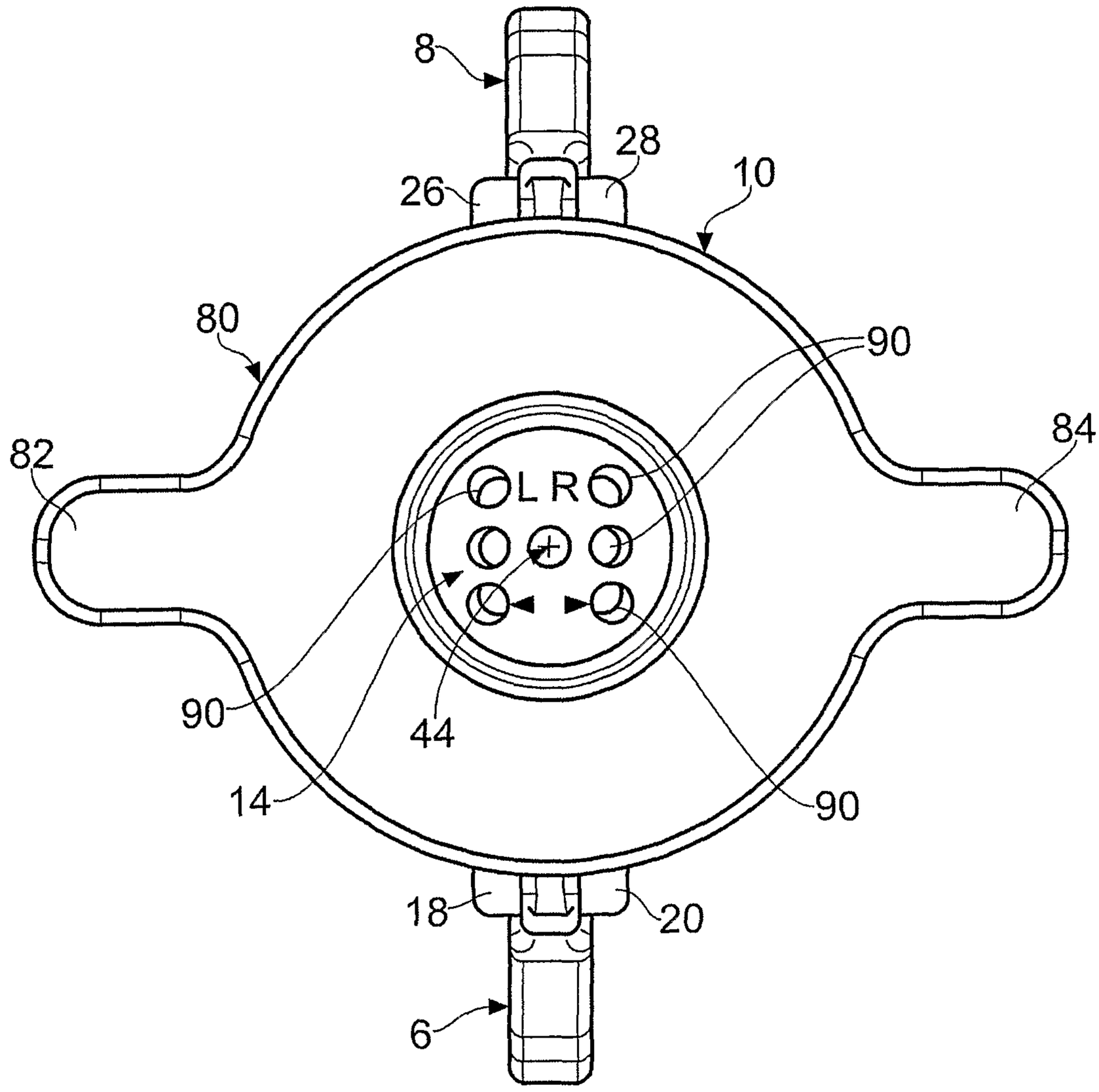

FIG. 2

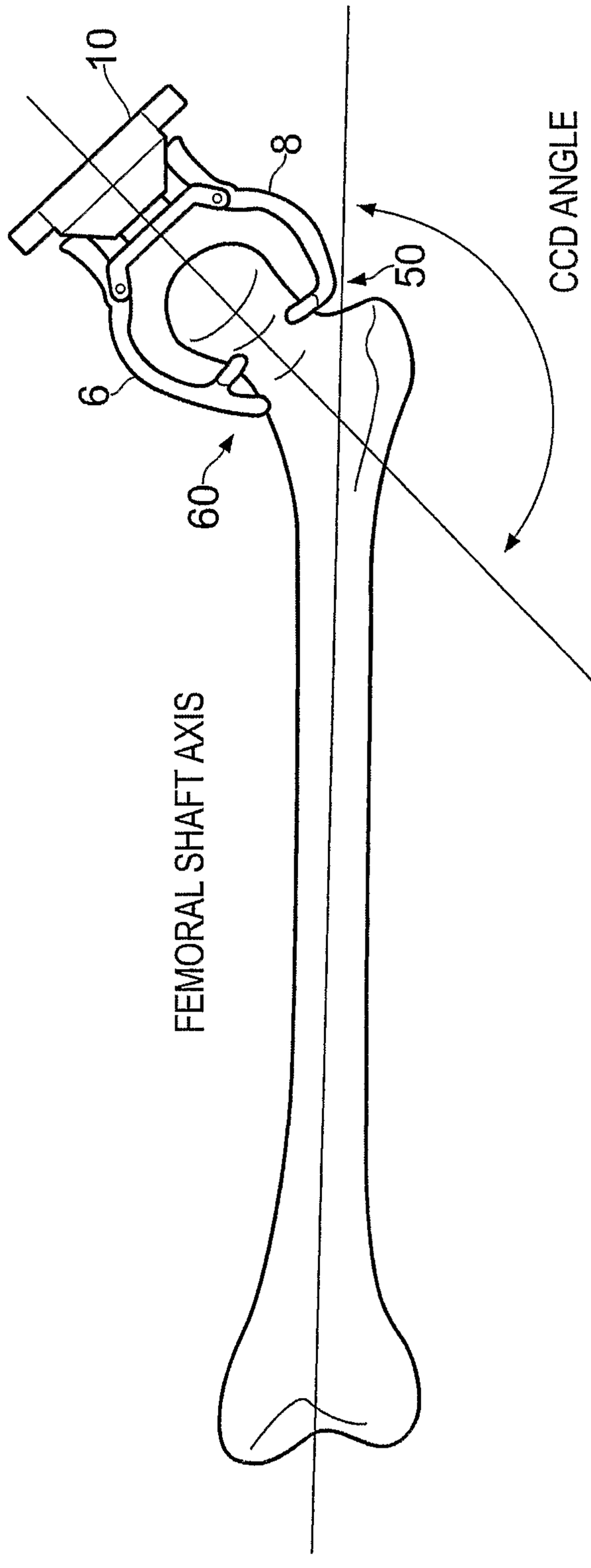

FIG. 3

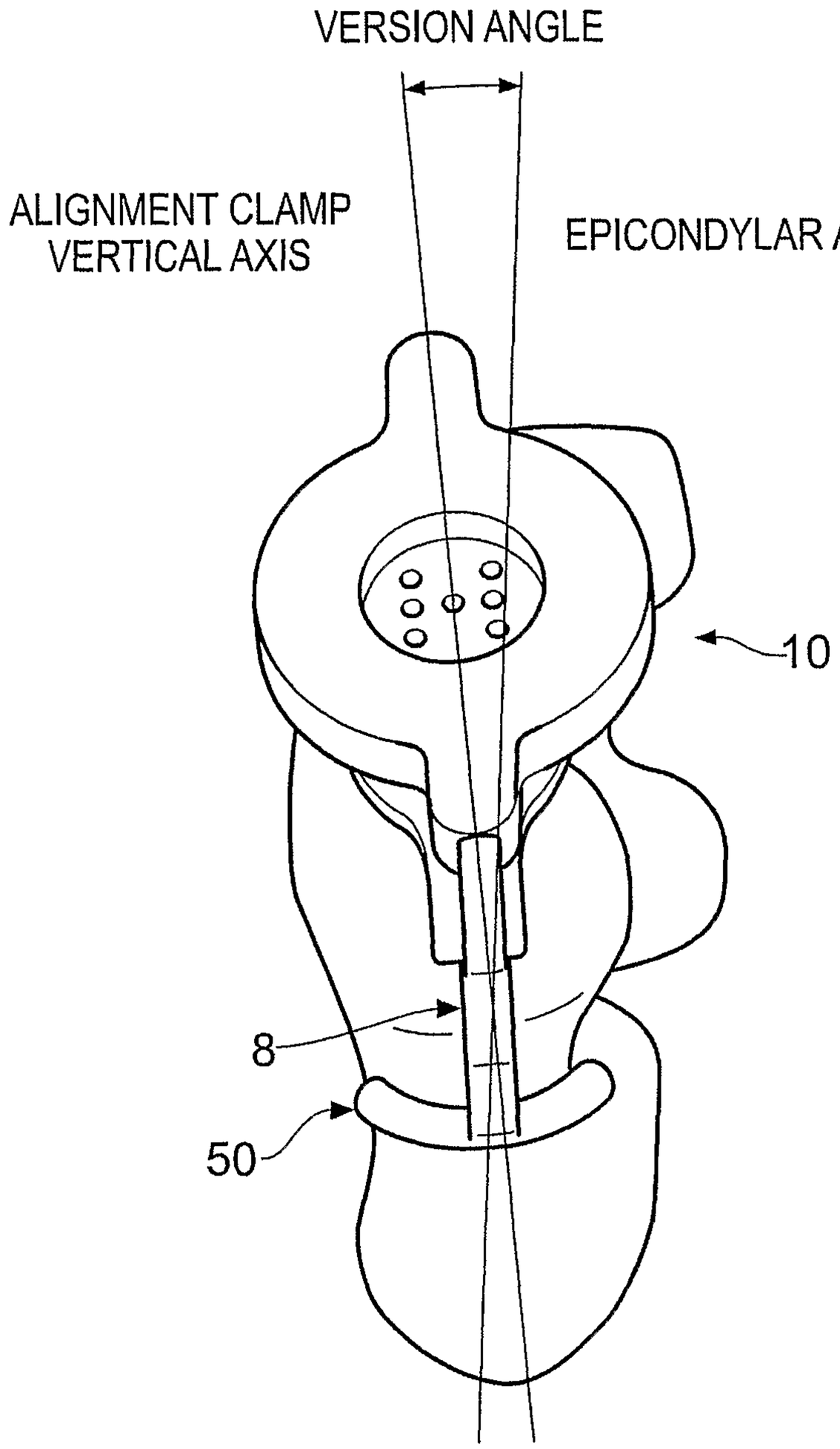
VERSION ANGLE
ALIGNMENT CLAMP
VERTICAL AXIS
EPICONDYLAR AXIS
10
8
50

FIG. 4

SURGICAL INSTRUMENT

This invention relates to a surgical instrument and particularly, but not exclusively, relates to an instrument having a tool guide and a clamping arrangement, the clamping arrangement clamping the instrument to a bone, and at the same time aligning the tool guide with the bone.

BACKGROUND

During all types of joint replacement surgery, and in many other surgical procedures, it is necessary to make specific cuts or to drill holes into specific areas of bone. Both the point and angle of entry of the cut or drill hole is important. This is particularly so in the case, for example, of femoral head resurfacing, where it is necessary to drill a pilot hole that passes through the centre of the femoral neck at a specific angle with respect both to the epicondylar axis and the femoral shaft axis. Guide tools exist to aid surgeons in the placement of bone cuts and guide holes. Such tools are often difficult and time consuming to operate, and are inaccurate. Many of the tools of the prior art are also bulky, requiring the removal or displacement of large areas of soft tissue in order to be used.

Use of conventional tool guides generally involves at least the steps of attaching the guide, referencing the position of the guide from an anatomical feature, and adjusting the position of the guide to correspond to the optimal position indicated in the referencing step. Several iterations of referencing and adjustment may be required to achieve the correct position and orientation of the guide.

STATEMENTS OF INVENTION

According to a first aspect of the present invention, there is provided an instrument for aligning a surgical tool, the instrument comprising, a body portion having a tool guide, first and second arms operatively connected to the body portion and adapted to engage a bone, and urging means, acting between the body portion and the first and second arms, for urging the first and second arms into engagement with a predetermined portion of a bone, thereby clamping the arms onto the bone and aligning the tool guide with the bone.

The first and second arms may terminate in first and second jaws. The first jaw may be curved and the second jaw may be bifurcated and may have at least two distinct jaw elements. As the instrument contacts the bone in at least three distinct points or areas, the instrument is held in a very stable manner relative to the bone.

The first and second arms may be pivotally connected to the body portion. Alternatively, the first and second arms may be connected to the body portion by means of a linkage which constrains the arms to translate laterally of the body portion towards and away from one another. The linkage may be a quadrilateral linkage. The advantage of constraining the arms to translate laterally is that the angle of the arms relative to a longitudinal axis of the body portion does not change irrespective of the diameter of the bone to be clamped. This enhances the accuracy of referencing and hence the alignment of the tool guide compared to an instrument having pivoting arms, irrespective of the size of the patient.

The first and second arms may be disposed on opposite sides of the body portion. Additional arms may also be provided. For example, three arms may be provided spaced equidistantly around the circumference of the body portion.

The urging means may engage the body portion via a threaded connection, and the urging means may be a nut. The nut may comprise a tapering engagement surface, configured to engage the first and second arms directly.

The body portion may comprise a post having projecting tabs that extend from the base of the post. The first and second arms may be mounted in opposed recesses formed in the projecting tabs. Each arm may be pivotably connected to one of the tabs by means of a pinned joint.

Each arm may be connected to the body portion at an intermediate position along its length.

The tool guide may be provided with a plurality of tool guiding openings. At least one of the tool guiding openings may be differently aligned to the or each other tool guiding openings, so that when the first and second arms are clamped to the bone, the said tool guiding opening is aligned with a different part of the bone from the or each other tool guiding opening.

The tool guiding openings may comprise bores having longitudinal axes at least some of which converge at a point a predetermined distance proximal of the body portion. The longitudinal axes of some of the bores may converge at a different point from the longitudinal axes of some others of the bores.

The provision of a plurality of guide holes or bores enables the surgeon to select an appropriate bore which might compensate for minor misalignment of the instrument. Furthermore, having groups of bores aligned, such that their longitudinal axes intersect at specific points, further increases the options that the surgeon has in selecting an appropriate bore to accommodate minor misalignment or variations in patient anatomy.

According to a second aspect of the present invention, there is provided an instrument for aligning a surgical tool, the instrument comprising a body portion, at least two arms pivotably connected to the body portion and a nut which engages a thread formed on the body portion, the nut engaging the arms as it is threaded onto the body portion in use, thereby forcing the free ends of the arms together to clamp a bone.

According to a third aspect of the present invention, there is provided an instrument for aligning a surgical tool, the instrument comprising a body portion, means for clamping the body portion to a bone, and a tool guide having a plurality of tool guide bores, longitudinal axes of some of the bores converging at a different point from longitudinal axes of others of the bores.

The instrument my be used in a method of aligning a tool guide, the method comprising the steps of:

a placing the arms of the instrument about a predetermined portion of a bone; and

b operating the urging means to force the arms to clamp the bone, thereby aligning the tool guide with the bone.

The present invention represents a considerable advance over prior art devices, since simply by operating the urging means to force the arms to clamp a predetermined portion of the bone, the tool guide is automatically aligned with the bone. This is achieved because the arms of the instrument reference on a predetermined portion of the bone which has a known orientation relative to the part of the bone which is to be drilled, cut of otherwise worked. The automatic alignment provided by the device means that no additional visual checks of the alignment of the device are required, thereby speeding up the surgical procedure. Furthermore, the level of skill and experience required in the surgeon using the instrument is reduced, whilst the accuracy of the

surgery is increased. The instrument is also adaptable to different sizes of bone, so that a single instrument can be used on many patients.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention, and to show more clearly how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which: —

FIG. **1** is an exploded perspective view of a surgical instrument,

FIG. **2** is a plan view of the instrument of FIG. **1**,

FIG. **3** is a side view of the instrument of FIG. **1** mounted on a femur, and

FIG. **4** is an end view of the instrument illustrated in FIG. **3**.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

With reference to FIG. **1**, a surgical instrument **2** comprises a body portion **4**, a pair of opposed first and second arms **6**, **8** pivotally connected to the body portion **4**, and a nut **10** mountable on the body portion **4**. The body portion **4** comprises an annular flange **12** and a post **14** that carries an external thread **15**.

In this specification, the terms "distal" and "distally" mean towards the threaded end of the surgical instrument **2**, and the terms "proximal" and "proximally" mean towards the opposite end of the surgical instrument **2**.

The post **14** projects substantially perpendicularly from a distal surface **16** of the flange **12**. A first tab **11** projects from a first (or inferior) side of the flange **12** and is bifurcated. A recess **22** is defined between substantially parallel forks **18**, **20** of the first bifurcated tab **11**. A second bifurcated tab **30** projects from an opposite (or superior) side of the flange **12**. A second recess **24** is defined between substantially parallel forks **26**, **28** of the second bifurcated tab **30**.

The arms **6**, **8** are mounted on the tabs **11** and **30** for pivotal motion relative to the flange **12** and post **14**. The arm **6** is mounted between the forks **18**, **20** on a pin **32** which extends through the forks **18**, **20**, and the arm **8** is mounted between the forks **26**, **28** on a pin **34** which extends through the forks **26**, **28**. Each arm **6**, **8** includes a cylindrical bore (not shown) extending across the width of the arm **6**, **8**, at an intermediate position along its length, through which the corresponding pin **32**, **34** passes.

Other means of pivotable connections are contemplated, such as replacing the pins **32**, **34** with set screws, rivets, or nut and bolt arrangements. In an alternative embodiment, not illustrated, the arms **6**, **8** are connected to the body portion **4** by a quadrilateral linkage so that the arms **6**, **8** move laterally of the body portion **4**, rather than pivoting about the tabs **11**, **30**.

Each arm **6**, **8** extends both proximally and distally of its respective bore such that, when mounted in the recesses **22**, **24**, each arm comprises a referencing portion **40**, **42**, that extends proximally of the flange **12**, and an engaging portion **36**, **38**, that extends distally of the flange **12**. Each arm **6**, **8** is substantially "S" shaped, and is mounted in its corresponding recess **22**, **24** such that the engaging portion **36**, **38** is directed away form a central axis **44** of the post **14** and the referencing portion **40**, **42** is directed towards the central axis **44** of the post **14**.

The referencing portion **42** of the arm **8** mounted in the second recess **24** (the superior arm) terminates at its free end in a jaw **50**. The jaw **50** comprises a single jaw element **52** that extends arcuately so as to define an internal, bone receiving surface **54**. The referencing portion **40** of the arm **6** mounted in the first recess **22** (the inferior arm) terminates at its free end in a jaw **60**. The jaw **60** is bifurcated, comprising two jaw elements **62**, **64** that each extend arcuately so as to define internal, bone receiving surfaces **66**, **68**.

The engagement portions **36**, **38** of the arms **6**, **8** define opposed curved cam surfaces **72**, **74** that cooperate with an annular engagement surface formed on the nut **10**.

The nut **10** comprises a bore **76** having an internal thread **77**. The thread **77** cooperates with the external thread **15** formed on the post **4**. The nut **10** has a frustoconical engagement surface **78** that tapers outwardly from the rim of the bore **76** to a cylindrical gripping surface **80**. Projections **82**, **84** are integrally formed with the cylindrical gripping surface **80** to facilitate rotation of the nut **10**. Alternatively, the cylindrical gripping surface **80** may be knurled, or otherwise adapted to facilitate turning by hand. In an embodiment not illustrated, the nut may be shaped to facilitate turning using a tool.

With reference to FIG. **2**, the post **14** comprises a series of guide bores **90** extending from a distal surface of the post **14**. The bores **90** are open, allowing communication from a distal to a proximal end of the body portion **4**. The post **14** may be hollow, in which case the flange **12** includes a corresponding opening and the bores **90** extend through the distal end wall of the post **14**. Alternatively, the post **14** may be solid, in which case the bores **90** extend through the length of the post **14** and the thickness of the flange **12**. At least one bore **90** is positioned such that the axis of the bore **90** coincides with the longitudinal axis **44** of the post **14**. The bores **90** are orientated such that the longitudinal axes of the bores **90** converge on predetermined points which are predetermined distances proximal of the body portion **4**.

The instrument **2** is particularly suited for use in surgical procedures involving the hip and shoulder.

With reference to FIGS. **3** and **4**, the instrument **2** may be used to guide a femoral alignment pin during a femoral resurfacing procedure. Prior to use, the instrument **2** is prepared by unscrewing the nut **10**, so as to allow free pivoting motion of the arms **6**, **8**. The instrument is then placed over the femoral head with the inferior arm **6** on the inferior side of the femoral neck and the superior arm **8** on the superior side of the femoral neck. The nut **10** is then screwed onto the post **14**. As the nut **10** progresses proximally down the post **14**, the engagement surface **78** of the nut **10** contacts the cam surfaces **72**, **74** of the engagement portions **36**, **38** of the arms **6**, **8**. Further proximal motion of the nut **10** forces the engagement portions **36**, **38** of the arms **6**, **8** apart, thus bringing the jaws **50**, **60** of the arms **6**, **8** into contact with the femoral neck. The nut **10** is screwed onto the post **14** until the jaws **50**, **60** are firmly clamped around the femoral neck. The regions or points of contact provided by the three jaw elements **52**, **64**, **66** ensure a stable connection between the instrument and the bone.

With the instrument correctly mounted on the bone, the inferior, bifurcated jaw **60** provides a three dimensional reference of the calcar surface of the femoral neck. The superior jaw **50** provides a two dimensional reference of the superior surface of the femoral neck. The position at which the instrument centres itself on the femoral neck is thus determined by the inferior angle of the femoral neck (the calcar angle) and by the diameter of the femoral neck. The curvature of the arms **6**, **8**, the curvatures of the cam surfaces and engagement surface **72**, **74**, **78**, and the orientation of the

bores **90** are selected such that, with the instrument clamped in the manner described above, the axes of the bores **90** converge towards the centre of the femoral neck and are aligned at an optimal collodiaphyseal angle (the angle between the femoral neck and shaft) and optimal anteversion to guide the insertion of a femoral alignment pin. The provision of several bores **90**, each having a slightly different orientation, allows a surgeon a certain flexibility, enabling the most appropriate orientation for a particular patient to be selected.

The invention claimed is:

1. An instrument for aligning a surgical tool on a femoral head and a femoral neck of a femur, the instrument comprising:

a body portion having a threaded post fixed to the body portion and projecting proximally, along a longitudinal axis, from a proximal surface of the body portion,

a first arm, and a second arm, the first arm and the second arm each pivotably connected to the body portion via a first fork and a second fork, respectively, extending from opposite sides of the post and fixed to the body portion, each of the first and second arms having a distal portion, a proximal portion, and a coupling portion located between the distal and proximal portions, each of the coupling portions being coupled to one of the opposing forks by a pivot pin, wherein the distal portion of each of the first arm and the second arm is curved along a length of the distal portion forming a concave bone facing surface, a distal end of the distal portion of the second arm including a bifurcated tab including two curved jaw elements for engaging the femoral neck, and a distal end of the distal portion of the first arm including a curved jaw for engaging the femoral neck, the proximal portion of each of the first arm and the second arm including a curved cam surface,

the threaded post comprising at least a first bore and a second bore extending therethrough, the first bore having a first longitudinal axis differently aligned from a second longitudinal axis of the second bore, and the first and the second longitudinal axes are differently aligned from the longitudinal axis of the post; and

a nut having a threaded bore configured to threadably engage the post, the nut including a frustoconical engagement surface that tapers outwardly from the threaded bore, the frustoconical engagement surface configured to engage the curved cam surfaces of the proximal portions of the first and second arms and causes the two curved jaw elements and the curved jaw of the first and second arms to engage a predetermined portion of the femoral neck upon threading the nut along the post,

wherein when the first and second arms are clamped on the femoral neck, the first longitudinal axis and the second longitudinal axis converge towards a center portion of the femoral head at a point at a predetermined distance proximate the body portion, the point being located inside the femoral head when the instrument engages the femoral neck.

2. The instrument of claim **1**, wherein the curved jaw of the first arm is curved to match a profile of the femoral neck.

3. The instrument of claim **1**, wherein the first fork and the second fork each constrains lateral motion of the first arm and the second arm, respectively, towards and away from one another.

4. The instrument of claim **1**, wherein longitudinal axes of a third bore and a fourth bore each converge at a different point from the first longitudinal axis and the second longitudinal axis.

5. The instrument of claim **1**, wherein the post is configured to allow for drilling an alignment hole into the femoral neck of the femoral head.

6. A surgical instrument for aligning a surgical tool on a femoral head and a femoral neck of a femur, the surgical instrument comprising:

a body portion having opposed forks and an intermediate annular flange having a proximal surface and a distal surface, a threaded post fixed to the body portion and projecting proximally, along a first longitudinal axis, from the proximal surface of the body portion, the post including a plurality of guide bores extending therethrough, at least two of the plurality of guide bores extending through the threaded post along longitudinal axes at different angles relative to each other and to the first longitudinal axis of the threaded post;

a first arm and a second arm each pivotably coupled to one of the opposed forks of the body portion, each of the first and second arms having a distal portion, a proximal portion, and a coupling portion located between the distal and proximal portions, each of the coupling portions being coupled to one of the opposing forks by a pivot pin, wherein the distal portion of each of the first arm and the second arm is curved along a length of the distal portion forming a concave bone facing surface, a distal end of the distal portion of the second arm including a bifurcated tab including two curved jaw elements for engaging the femoral neck, and a distal end of the distal portion of the first arm including a curved jaw for engaging the femoral neck, the proximal portion of each of the first arm and the second arm including a curved cam surface; and

a nut having a threaded bore configured to threadably engage the post, the nut including a frustoconical engagement surface that tapers outwardly from the threaded bore, the frustoconical engagement surface engages the curved cam surfaces of the proximal portions of the first and second arms and configured to urge the curved jaw of the first arm and the two curved jaw elements of the second arm together to contact the femoral neck upon threading the nut along the post,

wherein the at least two of the plurality of guide bores are configured such that when the jaws of the first and second arms are in contact with the femoral neck, the longitudinal axes of the bores are aligned at a predetermined collodiaphyseal angle between the femoral neck and a shaft of the femur, and are aligned at a predetermined anteversion.

7. The surgical instrument of claim **6**, wherein motion of the first arm and the second arm is restricted to a first direction in which the distal ends of the first and second arms move towards one another, and a second direction in which the distal ends of the first and second arms move apart.

8. The surgical instrument of claim **6**, wherein the axes of the at least two of the plurality of guide bores converge inside the femoral neck bone when the surgical instrument is coupled to the femoral neck.

* * * * *